

What is claimed is:

1. A transreflector comprising:

a transreflector body having a first surface and a second surface, the second surface being a structured surface comprising a plurality of prismatic structures having a first facet and a second facet, the first facet making an angle with respect to the second facet that is no more than about 70 degrees;

5 wherein, in a reflective mode, light incident onto the first surface at a reflected incident angle is refracted through the first surface, reflected at the first facet of a first prismatic structure, reflected at the second facet of a second prismatic structure, and 10 refracted through the first surface with a maximum intensity at about a reflected exit angle, and

15 in a transmissive mode, light incident onto the second surface at a transmitted incident angle is directed by a prismatic structure to the first surface and refracted through the first surface with a maximum intensity at about a transmitted exit angle.

2. The transreflector as recited in claim 1, wherein the reflected exit angle is about the same as the transmitted exit angle.

3. The transreflector as recited in claim 1, wherein the first surface of the transreflector 20 body is substantially planar.

4. The transreflector as recited in claim 1, wherein each first facet makes a first angle and each second facet makes a second angle with respect to a normal to the first surface and absolute values of the first and second angles are from about 22° to about 42°.

5. The transreflector as recited in claim 1, wherein absolute values of the reflected and transmitted exit angles are from about 0 degrees to about 20 degrees with respect to an axis normal to the first surface.

5

6. The transreflector as recited in claim 1, wherein absolute value of the transmitted incident angle is from about 100 to about 120 degrees with respect to an axis normal to the first surface.

10 7. The transreflector as recited in claim 1, wherein absolute value of the reflected incident angle is from about 20 to about 40 degrees with respect to an axis normal to the first surface.

15 8. The transreflector as recited in claim 1, wherein the second surface comprises prismatic structures having curved facets.

9. The transreflector as recited in claim 1, wherein the transreflector body comprises a volume diffuser.

20 10. The transreflector as recited in claim 1, further comprising a layer of diffuse material disposed on the first surface.

11. The transreflector as recited in claim 1, wherein at least one of the surfaces of the transreflector body is roughened.

12. The transreflector as recited in claim 1, wherein the second surface comprises a pattern of structural variations.

5 13. The transreflector as recited in claim 1, wherein the second surface comprises prismatic structures of different average heights.

14. The transreflector as recited in claim 1, further comprising a substrate attached to the first surface.

10 15. The transreflector as recited in claim 14, wherein the substrate comprises at least one of: a reflective polarizer, an absorbing polarizer, and a diffuser.

16. A transreflector comprising:

15 a transreflector body having a first surface and a second surface, the second surface being a structured surface comprising a plurality of prismatic structures having a first facet and a second facet, each first facet making a first angle and each second facet making a second angle with respect to a normal to the first surface, and absolute values of the first angles being different from absolute values of the second angles;

20 wherein, in a reflective mode, light incident onto the first surface at a reflected incident angle is refracted through the first surface, reflected at the first facet of a first prismatic structure, reflected at the second facet of a second prismatic structure, and refracted through the first surface with a maximum intensity at about a reflected exit angle, and

in a transmissive mode, light incident onto the second surface at a transmitted incident angle is directed by a prismatic structure to the first surface and refracted through the first surface with a maximum intensity at about a transmitted exit angle.

5 17. The transflector as recited in claim 16, wherein the reflected exit angle is about the same as the transmitted exit angle.

18. The transflector as recited in claim 16, wherein the first surface of the transflector body is substantially planar.

10 19. The transflector as recited in claim 16, wherein absolute values of the first and second facet angles are from about 22° to about 42°.

15 20. The transflector as recited in claim 16, wherein absolute values of the reflected and transmitted exit angles are from about 0 degrees to about 20 degrees with respect to an axis normal to the first surface.

20 21. The transflector as recited in claim 16, wherein absolute value of the transmitted incident angle is from about 100 to about 120 degrees with respect to an axis normal to the first surface.

22. The transflector as recited in claim 16, wherein absolute value of the reflected incident angle is from about 20 to about 40 degrees with respect to an axis normal to the first surface.

23. The transflector as recited in claim 16, wherein the second surface comprises prismatic structures having curved facets.

5 24. The transflector as recited in claim 16, wherein the transflector body comprises a volume diffuser.

25. The transflector as recited in claim 16, further comprising a layer of diffuse material disposed on the first surface.

10

26. The transflector as recited in claim 16, wherein at least one of the surfaces of the transflector body is roughened.

15 27. The transflector as recited in claim 16, wherein the second surface comprises a pattern of structural variations.

28. The transflector as recited in claim 16, wherein the second surface comprises prismatic structures of different average heights.

20 29. The transflector as recited in claim 16, further comprising a substrate attached to the first surface.

30. The transflector as recited in claim 29, wherein the substrate comprises at least one of: a reflective polarizer, an absorbing polarizer, and a diffuser.

31. A transreflector comprising:

a transreflector body having a refractive index, a first surface and a second surface, the second surface being a structured surface comprising a plurality of prismatic structures having a first facet and a second facet, each first facet making a first angle and each second facet making a second angle with respect to a normal to the first surface;

wherein the refractive index, the first angles and the second angles of the transreflector body are configured for transrefective operation characterized by a transmitted exit angle and a reflected exit angle, so that

10 in a reflective mode, light incident onto the first surface at a reflected incident angle is refracted through the first surface, reflected at the first facet of a first prismatic structure, reflected at the second facet of a second prismatic structure, and refracted through the first surface with a maximum intensity at about the reflected exit angle, and

15 in a transmissive mode, light incident onto the second surface at a transmitted incident angle is directed by a prismatic structure to the first surface and refracted through the first surface with a maximum intensity at about the transmitted exit angle.

32. The transreflector as recited in claim 31, wherein the reflected exit angle is about the same as the transmitted exit angle.

20
33. The transreflector as recited in claim 31, wherein the first surface of the transreflector body is substantially planar.

34. The transreflector as recited in claim 31, wherein absolute values of the first and second facet angles are from about 22° to about 42°.

35. The transreflector as recited in claim 31, wherein absolute values of the reflected 5 and transmitted exit angles are from about 0 degrees to about 20 degrees with respect to an axis normal to the first surface.

36. The transreflector as recited in claim 31, wherein absolute value of the transmitted incident angle is from about 100 to about 120 degrees with respect to an axis 10 normal to the first surface.

37. The transreflector as recited in claim 31, wherein absolute value of the reflected incident angle is from about 20 to about 40 degrees with respect to an axis normal to the first surface.

15

38. The transreflector as recited in claim 31, wherein the second surface comprises prismatic structures having curved facets.

39. The transreflector as recited in claim 31, wherein the transreflector body comprises 20 a volume diffuser.

40. The transreflector as recited in claim 31, further comprising a layer of diffuse material disposed on the first surface.

41. The transflector as recited in claim 31, wherein at least one of the surfaces of the transflector body is roughened.

42. The transflector as recited in claim 31, wherein the second surface comprises a 5 pattern of structural variations.

43. The transflector as recited in claim 31, wherein the second surface comprises prismatic structures of different average heights.

10 44. The transflector as recited in claim 31, further comprising a substrate attached to the first surface.

45. The transflector as recited in claim 44, wherein the substrate comprises at least one of: a reflective polarizer, an absorbing polarizer, and a diffuser.

15

46. A display module comprising:
a transmissive image-forming device,
a backlight, and
a transflector having a body, the body having a first surface and a second surface,
20 the second surface being a structured surface that comprises a plurality of prismatic structures having a first facet and a second facet, the first facet making an angle with respect to the second facet that is no more than about 70 degrees, said transflector disposed between the image-forming device and the backlight so that the first surface faces the image-forming device and the second surface faces the backlight;

wherein, in a reflective mode, light transmitted through the image-forming device at and incident onto the first surface at a reflected incident angle is refracted through the first surface, reflected at the first facet of a first prismatic structure, reflected at the second facet of a second prismatic structure, refracted through the first surface, and transmitted 5 through the image-forming device with a maximum intensity at about a reflected exit angle, and

in a transmissive mode, light originating from the backlight and incident onto the second surface at a transmitted incident angle is directed by a prismatic structure to the first surface, refracted through the first surface, and transmitted through the image-forming 10 device with a maximum intensity at about a transmitted angle.

47. The display module as recited in claim 46, wherein the reflected exit angle is about the same as the transmitted exit angle.

15 48. The display module as recited in claim 46, wherein the first surface of the transreflector body is substantially planar.

49. The display module as recited in claim 46, wherein each first facet makes a first angle and each second facet makes a second angle with respect to a normal to the first 20 surface and absolute values of the first and second angles are from about 22° to about 42°.

50. The display module as recited in claim 46, wherein absolute values of the reflected and transmitted viewing angles are from about 0 degrees to about 20 degrees with respect to an axis normal to the first surface.

51. The display module as recited in claim 46, wherein absolute value of the transmitted incident angle is from about 100 to about 120 degrees.

5 52. The display module as recited in claim 46, wherein absolute value of the reflected incident angle is from about 20 to about 40 degrees.

53. The display module as recited in claim 46, wherein the second surface of the transreflector comprises prismatic structures having curved facets.

10

54. The display module as recited in claim 46, wherein the transreflector body comprises a volume diffuser.

15

55. The display module as recited in claim 46, further comprising a layer of diffuse material disposed on the first surface of the transreflector body.

56. The display module as recited in claim 46, wherein at least one of the surfaces of the transreflector body is roughened.

20

57. The display module as recited in claim 46, wherein the second surface comprises a pattern of structural variations.

58. The display module as recited in claim 46, wherein the second surface comprises prismatic structures of different average heights.

59. The display module as recited in claim 46, further comprising a substrate attached to the first surface.

5 60. The display module as recited in claim 59, wherein the substrate comprises at least one of: a reflective polarizer, an absorbing polarizer, and a diffuser.

61. The display module as recited in claim 46, wherein the transflector is attached to the transmissive image-forming device.

10

62. The display module as recited in claim 61, wherein the transmissive image-forming device comprises a liquid crystal panel disposed between two polarizers and wherein the transflector is attached to an adjacent polarizer.

15

63. The display module as recited in claim 62, wherein the transflector is attached to the adjacent polarizer using a diffuse adhesive.

64. The display module as recited in claim 46, wherein the backlight comprises a light source, a lightguide optically connected to the light source and a back reflector.

20

65. The display module as recited in claim 64, wherein the lightguide is generally wedge-shaped with a thickness gradually tapering in a direction away from the light source.

66. A display module comprising:

a transmissive image-forming device,

a backlight, and

a transreflector having a body, the body having a first surface and a second surface,

5 the second surface being a structured surface that comprises a plurality of prismatic structures having a first facet and a second facet, each first facet making a first angle and each second facet making a second facet with respect to a normal to the first surface, and absolute values of the first angles being different from absolute values of the second angles; said transreflector disposed between the image-forming device and the backlight so that the

10 first surface faces the image-forming device and the second surface faces the backlight;

wherein, in a reflective mode, light transmitted through the image-forming device at and incident onto the first surface at a reflected incident angle is refracted through the first surface, reflected at the first facet of a first prismatic structure, reflected at the second facet of a second prismatic structure, refracted through the first surface, and transmitted through the image-forming device with a maximum intensity at about a reflected exit angle, and

in a transmissive mode, light originating from the backlight and incident onto the second surface at a transmitted incident angle is directed by a prismatic structure to the first surface, refracted through the first surface, and transmitted through the image-forming device with a maximum intensity at about a transmitted angle.

67. The display module as recited in claim 66, wherein the reflected exit angle is about the same as the transmitted exit angle.

68. The display module as recited in claim 66, wherein the first surface of the transreflector body is substantially planar.

69. The display module as recited in claim 66, wherein absolute values of the first 5 and second angles are from about 22° to about 42°.

70. The display module as recited in claim 66, wherein absolute values of the reflected and transmitted viewing angles are from about 0 degrees to about 20 degrees with respect to an axis normal to the first surface.

10

71. The display module as recited in claim 66, wherein absolute value of the transmitted incident angle is from about 100 to about 120 degrees.

72. The display module as recited in claim 66, wherein absolute value of the 15 reflected incident angle is from about 20 to about 40 degrees.

73. The display module as recited in claim 66, wherein the second surface of the transreflector comprises prismatic structures having curved facets.

20 74. The display module as recited in claim 66, wherein the transreflector body comprises a volume diffuser.

75. The display module as recited in claim 66, further comprising a layer of diffuse material disposed on the first surface of the transreflector body.

76. The display module as recited in claim 66, wherein at least one of the surfaces of the transreflector body is roughened.

5 77. The display module as recited in claim 66, wherein the second surface comprises a pattern of structural variations.

78. The display module as recited in claim 66, wherein the second surface comprises prismatic structures of different average heights.

10

79. The display module as recited in claim 66, further comprising a substrate attached to the first surface.

15 80. The transreflector as recited in claim 79, wherein the substrate comprises at least one of: a reflective polarizer, an absorbing polarizer, and a diffuser.

81. The display module as recited in claim 66, wherein the transreflector is attached to the transmissive image-forming device.

20 82. The display module as recited in claim 81, wherein the transmissive image-forming device comprises a liquid crystal panel disposed between two polarizers and wherein the transreflector is attached to an adjacent polarizer.

83. The display module as recited in claim 82, wherein the transreflector is attached to the adjacent polarizer using a diffuse adhesive.

84. The display module as recited in claim 66, wherein the backlight comprises a 5 light source, a lightguide optically connected to the light source and a back reflector.

85. The display module as recited in claim 84, wherein the lightguide is generally wedge-shaped with a thickness gradually tapering in a direction away from the light source.

10

86. A display module comprising:
a transmissive image-forming device,
a backlight, and
a transreflector having a body, the body having a refractive index, a first surface and
15 a second surface, the second surface being a structured surface that comprises a plurality of prismatic structures having a first facet and a second facet, each first facet making a first angle and each second facet making a second facet with respect to a normal to the first surface, said transreflector disposed between the image-forming device and the
backlight so that the first surface faces the image-forming device and the second surface
20 faces the backlight;
wherein the refractive index, the first angles and the second angles of the transreflector body are configured for transflective operation characterized by a transmitted exit angle and a reflected exit angle, so that

in a reflective mode, light transmitted through the image-forming device at and
incident onto the first surface at a reflected incident angle is refracted through the first
surface, reflected at the first facet of a first prismatic structure, reflected at the second facet
of a second prismatic structure, refracted through the first surface, and transmitted through
5 the image-forming device with a maximum intensity at about the reflected exit angle, and

in a transmissive mode, light originating from the backlight and incident onto the
second surface at a transmitted incident angle is directed by a prismatic structure to the
first surface, refracted through the first surface, and transmitted through the image-forming
device with a maximum intensity at about the transmitted angle.

10

87. The display module as recited in claim 86, wherein the reflected exit angle is
about the same as the transmitted exit angle.

15

88. The display module as recited in claim 86, wherein the first surface of the
transflector body is substantially planar.

89. The display module as recited in claim 86, wherein absolute values of the first
and second angles are from about 22° to about 42°.

20

90. The display module as recited in claim 86, wherein absolute values of the
reflected and transmitted viewing angles are from about 0 degrees to about 20 degrees
with respect to an axis normal to the first surface.

91. The display module as recited in claim 86, wherein absolute value of the transmitted incident angle is from about 100 to about 120 degrees.

92. The display module as recited in claim 86, wherein absolute value of the 5 reflected incident angle is from about 20 to about 40 degrees.

93. The display module as recited in claim 86, wherein the second surface of the transflector comprises prismatic structures having curved facets.

10 94. The display module as recited in claim 86, wherein the transflector body comprises a volume diffuser.

95. The display module as recited in claim 86, further comprising a layer of diffuse material disposed on the first surface of the transflector body.

15 96. The display module as recited in claim 86, wherein at least one of the surfaces of the transflector body is roughened.

20 97. The display module as recited in claim 86, wherein the second surface comprises a pattern of structural variations.

98. The display module as recited in claim 86, wherein the second surface comprises prismatic structures of different average heights.

99. The display module as recited in claim 86, further comprising a substrate attached to the first surface.

100. The transreflector as recited in claim 99, wherein the substrate comprises at least 5 one of: a reflective polarizer, an absorbing polarizer, and a diffuser.

101. The display module as recited in claim 86, wherein the transreflector is attached to the transmissive image-forming device.

10 102. The display module as recited in claim 101, wherein the transmissive image-forming device comprises a liquid crystal panel disposed between two polarizers and wherein the transreflector is attached to an adjacent polarizer.

15 103. The display module as recited in claim 102, wherein the transreflector is attached to the adjacent polarizer using a diffuse adhesive.

104. The display module as recited in claim 86, wherein the backlight comprises a light source, a lightguide optically connected to the light source and a back reflector.

20 105. The display module as recited in claim 104, wherein the lightguide is generally wedge-shaped with a thickness gradually tapering in a direction away from the light source.

106. A method of making a transreflector, comprising the steps of:

selecting a reflected incident angle;

selecting a transmitted incident angle;

selecting a reflected exit angle;

selecting a transmitted exit angle; and

5 configuring a transreflector body having a first surface and a second surface, the second surface being a structured surface comprising a plurality of prismatic structures, so that

 in a reflective mode, light incident onto the first surface at the reflected incident angle is refracted through the first surface to a first prismatic structure, directed by the first

10 prismatic structure to a second prismatic structure, directed by the second prismatic structure to the first surface, and refracted through the first surface with a maximum intensity at about the reflected exit angle; and

 in a transmissive mode, light incident onto the second surface at the transmitted incident angle is directed by a prismatic structure to the first surface and refracted through

15 the first surface with a maximum intensity at about the transmitted exit angle.

107. The method of claim 106, wherein the transmitted exit angle is selected to be about the same as the reflected exit angle.

20 108. The method of claim 106, wherein the first surface is selected to be substantially planar.

109. A method of making a transreflector, comprising the steps of:

 selecting a reflected incident angle;

selecting a transmitted incident angle;
selecting a reflected exit angle;
selecting a transmitted exit angle; and
configuring a transreflector body having a refractive index, a substantially planar

5 surface and a structured surface comprising a plurality of prismatic structures having a first facet and a second facet, each first facet making a first angle and each second facet making a second angle with respect to a normal to the substantially planar surface, so that

10 in a reflective mode, light incident onto the substantially planar surface at the reflected incident angle is refracted through the substantially planar surface, reflected at the first facet of a first prismatic structure, reflected at the second facet of a second prismatic structure, and refracted through the substantially planar surface with a maximum intensity at about the reflected exit angle, and,

15 in a transmissive mode, light incident onto the structured surface at the transmitted incident angle is directed by a prismatic structure to the substantially planar surface and is refracted through the substantially planar surface with a maximum intensity at about the transmitted exit angle.

110. The method of claim 109, wherein the transmitted exit angle is selected to be substantially the same as the reflected exit angle.